

# On the value of natural ecosystems

## *The Catskills parable*

---

Mark Sagoff, Ph.D.

Institute for Philosophy and Public Policy,  
School of Public Affairs  
University of Maryland, College Park, MD 20742  
ms2@umail.umd.edu

---

**ABSTRACT.** Economic considerations typically have led societies to develop rather than to preserve wild and natural places. Accordingly, preservationists traditionally have based arguments for protecting nature on its intrinsic rather than instrumental worth. These traditional arguments rest on aesthetic, moral, and spiritual rather than on economic values. Today, though, many environmentalists point to the preservation of nature's "services" as the reason to protect ecosystems from conscious manipulation or careless degradation. Many cite a decision by New York City to spend over \$1 billion to purchase land in the Catskills watershed to secure or restore the capacity of the natural ecosystem to purify the City's water supply. This essay questions the validity of this example and, in turn, the generalizability of the thesis it has widely been thought to support.

---

**M**r. Douglas Tomkins, founder of two clothing companies, North Face and Esprit, says he "made way too much money" in these businesses. "Before I was a businessman, I was a mountaineer, and I came to know and love some of the world's wildest, most beautiful remaining places." In 1990, he says, "I sold all my business interests, immersed myself in the literature of deep ecology[,] . . . and have for the last twelve years spent virtually all my resources — time and money — to protect wild nature."<sup>1</sup>

Tomkins has purchased about 800,000 acres of land in Chile to form a nature reserve protecting, among many other natural wonders, about thirty-five percent of Chile's remaining *alerce*, a gigantic tree that can live for 4,000 years. The wilderness forests could have been harvested for pulp. Some of the land, once clear-cut, might have been farmed to provide fresh produce for winter consumption in the United States. Fjords there might have served as sites for salmon aquaculture. According to Adriana Delpiano, Chile's Minister of National Property, "Chile already has 2.5 million acres of national parks, and we don't need any more." She and others complain that Tomkin's nature reserve ties up too much resource-rich "land that could be used for development."<sup>2</sup>

### An economic rationale for preservation

In the United States, the conflict between preservation and development is an old story. For more than a century, preservationists have offered ethical and spiritual rather than economic arguments for protecting natural areas. John Muir, for example, sought to protect nature in spite of instrumental values, not because of them. Muir condemned the "temple destroyers, devotees of ravaging commercialism" who "instead of lifting their eyes to the God of the mountains, lift them to the Almighty dollar."<sup>3</sup>

A century ago, the battle over the damming of Hetch Hetchy, a spectacular valley carved from the Sierras by glaciers and the Tuolumne River, pitted those, like Muir, who loved nature for its intrinsic qualities against those, like Gifford Pinchot, who valued it at least as much for the uses to which it could be put. Pinchot, who had headed the Forest Service, would dedicate even Hetch Hetchy to human material benefit — in this instance, by turning it into a watering hole for San Francisco. Pinchot argued it would be irrational to keep the valley "untouched for the benefit of a very small number of well-to-do to whom it would be accessible."<sup>4</sup> Muir countered with a moral conviction, not an economic calculation. Society had a moral and religious duty to

respect so sacred and spectacular a monument. “Dam Hetch Hetchy! As well dam for water-tanks the people’s cathedrals and churches, for no holier temple has ever been consecrated by the heart of man.”<sup>5</sup>

Traditionally, those like Pinchot who have favored economic development have argued that technological intervention is usually required to obtain “services” from natural ecosystems, the way the construction of a dam realized the potential of Hetch Hetchy to serve as a water tank. To get the benefit of nature’s services is often to plow a field, dig a canal, build a road, drill a well, or alter a genome. To turn on a light switch, to purchase fresh produce year-round, to drive a car, or to dwell in a house is to depend not so much on nature directly but on technologies that lift the cup of nature to the lip of consumption.

Preservationists traditionally have avoided the economic approach to valuing ecosystems. They have tended to see and describe nature as a refuge from economic activity rather than as a resource for it, and they have characteristically appealed to the intrinsic, not the instrumental, value of nature, such as a remote wilderness or rare species, to justify the economic sacrifices often needed to protect it.

Today, many environmental activists, including many scientists, stand the traditional development-versus-preservation debate on its head by arguing that ecosystems should be preserved in their natural condition *for* rather than *in spite of* economic values and concerns. They argue that unspoiled nature provides long-term economic benefits that offset the short-term disadvantages involved in forgoing development. Environmental scientists argue that wild and natural ecosystems provide directly for our needs and, therefore, that we have sound instrumental reasons to leave nature alone. “Humanity obtains from natural ecosystems an array of ecosystem goods — organisms and their parts and products that grow in the wild and that are used directly for human benefit.”<sup>6</sup> Unfortunately, a “lack of awareness” of the economic value of undisturbed ecosystems “helps drive the conversion of natural ecosystems to human-dominated systems (e.g., wheatlands or oil palm fields).”<sup>7</sup> These scientists may agree with Muir in valuing nature for aesthetic, ethical, and spiritual reasons, but like Pinchot they favor economic arguments, possibly because they regard them as more effective. In the words of one, “The ethical arguments for saving biodiversity and the environment are not winning the war.”<sup>8</sup>

## The Catskills parable

Ecologists and other environmental scientists understand the power of examples. They know it is easy to find examples of human-dominated ecosystems — farms, homes, resorts — that may appear more serviceable than, say, the wild savannas, wetlands, or forests they have replaced. To be sure, the Nature Conservancy and other groups and individuals have acquired millions of acres of America’s “last great places” to protect them from development. These groups and individuals, however, respond to the intrinsic values, such as the beauty, age, and spiritual quality, they find in the landscapes they seek to retire from economic exploitation. What is wanted is an example that illustrates the economic or instrumental value of ecosystems left in a relatively natural, wild, or undisturbed state.

During the past few years, scientists have presented a telling example to illustrate the economic rationale for preserving wild or natural ecosystems. In the literature of environmental policy and science, this example more than any other presents evidence of the economic benefits that land in its natural state can provide.

In 1998, in “fundamentally important work,” two scholars “powerfully demonstrated through economic arguments” the value of undeveloped nature.<sup>9</sup> In a now routinely cited commentary in *Nature*, Graciela Chichilnisky and Geoffrey Heal,<sup>10</sup> economists at Columbia University, wrote, “In 1996, New York City invested between \$1 billion and \$1.5 billion in natural capital, in the expectation of producing cost savings of \$6 billion–\$8 over 10 years.” These authors explained, “New York City has floated an ‘environmental bond issue’ and will use the proceeds to restore the functioning of the watershed ecosystems responsible for water purification . . . .” Commentators have argued that this decision “demonstrated how New York City realized billions of dollars in economic benefits by sustaining the Catskills watershed as a water filtration system, rather than . . . building a new filtration plant.”<sup>11</sup>

The belief that New York City, to restore the purity of its water supply, has paid around \$1 billion to purchase and preserve land in the Catskills has led many scientists to accept an intuitively appealing hypothesis: we benefit more when we preserve nature than when we develop or cultivate it. Many scientists, including

those on prestigious boards and panels, have elaborated this idea. An eminent biologist recently has explained that, for generations, New York City received plenty of clean water from Catskills communities. “As their population grew, however, they converted more and more of the watershed forest into farms, homes, and resorts.” As a result, “the sewage and agricultural runoff adulterated the water, until it fell below Environmental Protection Agency [EPA] standards. Officials in New York City now faced a choice. They could build a filtration plant to replace the Catskill watershed, at a \$6 billion to \$8 billion capital cost, followed by \$300 million annual running costs, or they could restore the watershed to somewhere near its original purification capacity for \$1 billion.”<sup>12</sup>

The National Science Board of the National Science Foundation, in calling for research into the services ecosystems provide, now notes at its web site that historically the watershed of the Catskill Mountains filtered and purified water for New York City:

Over time, this watershed ecosystem became overwhelmed by sewage, industrial and agricultural runoff to the point that the water quality in the city fell below EPA drinking water standards. An economic analysis provided costs of two alternatives for restoring water quality. The cost of purchasing and restoring the watershed so that it could continue to provide the service of purification and filtration was calculated to be \$1 billion. The cost of building and maintaining a water purification and filtration plant was \$6–8 billion in capital costs, plus annual operating expenses of \$300 million. The City has opted to buy and restore the watershed, i.e., to let nature work for people.<sup>13</sup>

A panel of scientists, in a paper published at the Ecological Society of America (ESA) web site, repeats the same argument, reflecting the view of many ecologists that the City could best secure the purification services of natural ecosystems by withholding land from development. The panel argues that “preserving habitat in the watershed and letting the ecosystem do the work of cleansing the water” is “as effective as a new filtration plant. Habitat preservation and restoration costs one-fifth the price of a new filtration plant, avoids hundreds of millions of dollars in annual maintenance costs, and provides many other ecological and social benefits to the region.”<sup>14</sup>

Chichilnisky and Heal, in the original paper that provided the source of this information, wrote that in the Catskills, natural processes in the past “were sufficient to cleanse the water to standards required” by the EPA. “But sewage, fertilizer and pesticides in the soil reduced the efficiency of this process to the point where New York City’s water no longer met EPA standards.” As Chichilnisky and Heal continued, “The city was faced with the choice of restoring the integrity of the Catskill ecosystems or of building a filtration plant at a capital cost of \$6 billion–\$8 billion, plus running costs of the order of \$300 million annually. In other words, New York had to invest in natural capital or in physical capital. Which was more attractive?”<sup>15</sup>

A century ago, perhaps, one might have agreed with Pinchot that society had to invest in physical capital, i.e., technological infrastructure, to transform nature for human purposes, turning wetlands into farms or savannas into cities, constructing dams, tunnels, pipes, and treatment plants. The Catskills parable, as heretofore related, has taught the contrary lesson.

### **Problems with the parable**

The story that New York City paid about \$1 billion to restore or preserve the Catskills watershed is now often cited to show that ecological services can justify the preservation of nature even against well-designed development. Yet, the original paper cites no source as evidence for this story. An exhaustive study the National Research Council (NRC) published in 2000 found that the quality of New York City water had not declined in recent years. “Source water and drinking water in New York City are in compliance” with standards set by the Safe Drinking Water Act, the study reported, and “[t]he Catskill/Delaware water supply currently meets all necessary criteria.”<sup>16</sup>

Nor is it evident that natural purification processes until recently “were sufficient to cleanse the water to standards required” by the EPA, as the original paper stated. Since 1910, the City has relied on chlorine to disinfect its water supply.<sup>17</sup> The chlorine residues are so infinitesimal that the City easily complies with the residual standard for free chlorine and “little difficulty is expected meeting this requirement in the future as long as the City maintains its current disinfection practice.”<sup>18</sup>

## On the value of natural ecosystems

The Catskills watershed acts like a huge cistern that collects rain water, which is then captured in the reservoirs made by dams. It is not clear that rain water needs to be purified or filtered by the Catskills ecosystem. Actually, rain water approximates distilled water, albeit acidified distilled water in the northeastern United States, so impurities and surely pathogenic microorganisms are more likely to come *from*, rather than to be removed *by*, the landscape onto which rain water falls.

Through a complex of dams, reservoirs, aqueducts, pipes, and tunnels, New York City draws most of its water supply from 1,600 square miles in the Catskills and Delaware watersheds.<sup>19</sup> Working farms now occupy less than five percent of the watershed, and older farms, unable to compete with dairy and other operations farther west, are now largely reforested. Industrial and dense residential activity each account for less than one percent of the land use; most of the area is forest (68 percent) or otherwise vacant (10 percent).<sup>20</sup> According to the NRC study, the population of the Catskills watershed has hardly changed from what it was at the time of the Civil War. "In fact, the 1990 watershed population exceeded the estimated 1860 population by just 235 persons."<sup>21</sup>

The NRC study does note that microbes pathogenic to humans have increased enough from one source in the watershed in recent years to pose a serious problem. That source is wildlife. "Once extirpated from the region by marked hunting and trapping, white-tailed deer and beaver have rebounded during the last century." In regions where there is no livestock, "the background contamination from wildlife populations is apparent,"<sup>22</sup> and increases in fecal coliform bacteria, when observed in the principal reservoir, "coincided both spatially and temporally" with increases in waterfowl populations.<sup>23</sup> If water quality was to be assured, "Beaver populations may require active management in some parts of the watershed."<sup>24</sup>

If the quality of the water supplied to New York City had fallen below EPA standards, then people would have been in jeopardy. Fortunately, both source water and drinking water have remained in compliance with all necessary standards, according to the NRC. The statement that the "watershed ecosystem became overwhelmed by sewage, industrial and agricultural runoff to the point that the water quality in the city fell below EPA drinking water standards," has no identi-

fied foundation with respect to the Catskills watershed. In the Croton area, which provides about a tenth of the water supply, quality did decline, but New York City immediately opted to build a filtration plant at a cost of nearly \$700 million rather than to buy up or preserve watershed ecosystems.

Nor is there an evident basis for the statement that "New York City has floated an 'environmental bond issue' and will use the proceeds to restore the functioning of the watershed ecosystems responsible for water purification." A study of the archives of the New York City Municipal Water Finance Authority<sup>25</sup> indicates no such bond issue, and a telephone interview with the Authority's Director of Investment Relations confirmed that there was none.<sup>26</sup> In 1997, New York State authorized the Clean Water, Clean Air Bond Act, which committed \$1.75 billion to a variety of environmental projects statewide but earmarked no funds for land acquisition in the Catskills, though some of the money could have been or still might be used that way.<sup>27</sup>

If its water had not fallen from compliance with EPA standards, why did the City face a choice between 1) investing "between \$1 billion and \$1.5 billion in natural capital," supposedly the cost of purchasing and restoring the watershed, and 2) "building a filtration plant at a capital cost of \$6 billion–\$8 billion, plus running costs of the order of \$300 million annually"? Nothing had changed with respect to the safety or the quality of the City's water supply. The significant change took place not in the City or in its watershed but in Washington, D.C. What changed were specific regulations and the regulatory approach EPA adopted toward water treatment and watershed management.

On June 29, 1989, EPA promulgated the Surface Water Treatment Rule (SWTR),<sup>28</sup> which, indeed, confronted New York City with a choice. The SWTR required that every surface-water system serving more than 10,000 people, no matter how clean or safe its water, either filter that water or successfully petition to EPA for a "filtration avoidance determination" (FAD). This requirement had nothing to do with New York City in particular; its water remained excellent. The SWTR applied nationwide and was intended largely to deal with *Cryptosporidium parvum*, a microbe that survives chlorination and in 1993, despite the SWTR, was to pose a serious problem in Milwaukee.<sup>29</sup>

To comply with the STWR, the City could build a water filtration plant at a cost of \$6 billion, with main-

## *On the value of natural ecosystems*

tenance costs of \$300 million annually. Since its water already met high standards for safety and quality, the City had little to gain from this course. *C. parvum* could have become a problem, however, with about 350 vertebrate species, many able to act as carriers, thriving in the watershed. The City, however, had already begun to experiment with ultraviolet irradiation, a recognized alternative to the filtration of water containing *C. parvum* and other chlorine-resistant pathogens.<sup>30</sup>

Second, the City could — and did — petition for an FAD. On January 21, 1997, the City and EPA signed a Memorandum of Agreement that outlined steps the City would have to take to obtain a five-year filtration-avoidance determination, which it did receive.<sup>31</sup> EPA, in keeping with the watershed management approach it had by then adopted, had to be assured that the City would respect and protect the value of nature's services.<sup>32</sup> The City therefore committed itself to partner with landowners and communities to build infrastructure to make sure economic development would not impair water quality.

In applauding these aspects of the Agreement, the NRC committee thought that “moderate population growth and a wide range of new economic activities can be accommodated in the watershed without deleterious impacts on water quality as long as . . . infrastructure investments now being planned are put in place.”<sup>33</sup> These investments included subsidies for better sewage and septic systems and for improved farm waste management. These investments make long-term precautionary sense, though there are, in the NRC's words, “few signs that rapid increases in economic activity are likely in the region.”<sup>34</sup>

Had the City invested only in “technological capital” or infrastructure and refused to acquire land for preservation, it might have affronted ecologists inside EPA and out who recommended, to quote the ESA panel, “preserving habitat in the watershed and letting the ecosystem do the work of cleansing the water.” Since there was no scientific consensus about the amount of wildlife habitat that was needed to disinfect the water supply, however, the City and EPA had to make a political judgment about the number of acres the City would have to buy to satisfy those in authority who believed that wildlife habitat provided purification services. In the Memorandum of Agreement, the City committed to buy no set amount of land but to

solicit the purchase of 355,000 acres.<sup>35</sup> The amount of habitat the City would actually have to preserve was left vague.

Since 1997, the City has made significant investments in dam and pipe renovations, waste-treatment and septic-system improvement, and farm-operations enhancements. The City has attempted to begin work on a controversial \$680 million water filtration plant it seeks to site in Van Cortlandt Park in the Bronx,<sup>36</sup> and it has begun a multi-billion-dollar water tunnel project. In spite of the expectations of many environmentalists, it has not been as lavish, however, in the investments it has made in preserving wildlife habitat and biodiversity as a method purifying its water supply.

In fact, the extent of the City's habitat acquisition has disappointed environmentalists. In April 2001, an environmental group said the City “only secured a measly 36 acres of land surrounding the strategic reservoir — the Westchester County source for 90 percent of the city's drinking water.”<sup>37</sup> In a May 2000 report, EPA castigated the City for having bought only 17 undeveloped acres of the 1,000 available around a crucial reservoir in the Catskills system.<sup>38</sup> As of October 29, 2001, New York City had completed the purchase of only 17,250 acres across the entire watershed, most not by acquisition but through conservation easements.<sup>39</sup> A phone interview with City officials determined that as of the following February, only 19,200 acres had been purchased, at a cost of \$63.8 million. After September 11, 2001, the need to secure land around reservoirs as a protection against terrorism became evident, and land acquisitions could serve this purpose, yet the City has capped at \$260 million the amount it may eventually spend.<sup>40</sup>

The City is likely to see its FAD renewed even if it does not pick up the desultory pace of its investments in land reserves. It is apparent, however, that even by 1997, the City had bought enough land — virtually none — to reveal its own working estimate of the economic value of the surface-water purification services provided by undeveloped terrestrial ecosystems. Environmental scientists and others gave their version of this estimate. A document on the ESA website announced, “In 1996, New York City invested more than a billion dollars to buy land and restore habitat in the Catskill Mountains, the source of the city's fresh water supply.”<sup>41</sup> This was one of many publications that repeated, elaborated, and amplified the account

published in *Nature* in 1998 without relevant references, citations, or sources.

### The nature in nature's services

To understand the economic value of nature's services, one must define what it is to which the term "nature" refers. The term "nature," as John Stuart Mill wrote, can refer to either of two things. First, the term may denote "the aggregate of the powers and properties of all things. Nature means the sum of all phenomena, together with the causes which produce them; including not only all that happens, but all that is capable of happening."<sup>42</sup> In this sense, the opposite of the "natural" is the "supernatural." The failure of Biosphere II demonstrates the instrumental value of nature in this sense, if proof were needed. No one thinks that society can rely on technology to replace nature in the sense of everything under the sun plus the sun itself.

The term "nature" may also mean "not everything which happens, but only what takes place without the agency, or without the voluntary and intentional agency, of man." The opposite of the "natural" in this sense is the "artificial." The Catskills watershed constitutes a natural ecosystem in this sense just to the extent it follows its spontaneous course unhindered by human intervention or agency. To control beaver or deer populations, to build dams, canals, and pipes, or to apply chlorine is intentionally to alter nature's spontaneous course. The resulting goods and services can no longer be characterized as "natural" in the second sense of the term but only in the first.

Those who emphasize the economic value of nature's goods and services generally use the term "nature" in the second sense. According to a paper published by the RAND Corporation, "ecosystem services are the processes through which natural ecosystems, and the plants, animals and microbes that live in those environments, sustain human life." This definition excludes agriculture, silviculture, and aquaculture, sewage treatment plants, and any service that depends on humanity's manipulation of nature's course.<sup>43</sup> As its principal example of the value of natural ecosystems, the RAND study points to the "natural filtration services" the Catskills watershed provides New York City.

The Catskills parable has become ubiquitous because it offers a clear illustration of the thesis that

nature in the second sense — undeveloped nature — provides services spontaneously and that human manipulation, intervention, or transformation cannot improve and therefore can only diminish those services. The demonstrative power of this parable may explain the reluctance of many environmental scientists to question it. Yet by accepting examples of this sort hastily, environmentalists may eventually lose in credibility what they initially may gain in persuasiveness. By relying on economic or instrumental arguments, moreover, environmentalists appear to join those who, according to Muir, "instead of lifting their eyes to the God of the mountains, lift them to the Almighty dollar." They appeal to an instrumental ethic likely in the end to defeat them.

### References

1. Doug Tompkins, "Remarks to the 2001 Land Trust Alliance Rally," Baltimore, MD. October 2, 2001. <[http://www.lta.org/training/rally2001\\_tompkins.htm](http://www.lta.org/training/rally2001_tompkins.htm)>.
2. James Langman, "Thinking Big: After Founding Esprit and North Face, Doug Tompkins Dresses Up an 800,000-Acre Park," *e-magazine.com*, September-October 1997 <[http://www.emagazine.com/september-october\\_1997/0997curr\\_esprit.html](http://www.emagazine.com/september-october_1997/0997curr_esprit.html)>.
3. John Muir, *The Yosemite* (New York: Century Co., 1912), p. 256.
4. Char Miller, *Gifford Pinchot and the Making of Modern Environmentalism* (Washington: Island Press, 2001), pp. 140-141.
5. John Muir, "Hetch-Hetchy Valley," *Sierra Club Bulletin*, January 1908, p. 220.
6. Gretchen C. Daily, Susan Alexander, Paul R. Ehrlich et al., "Ecosystem Services: Benefits Supplied to Human Societies by Natural Ecosystems," published as a white paper by the Ecological Society of America <<http://esa.sdsc.edu/daily.htm>> and reprinted in *Issues in Ecology* No.2, Spring 1997.
7. G. C. Daily, S. Alexander, P. R. Ehrlich, et al., "Ecosystem Services: Benefits Supplied to Human Societies by Natural Ecosystems" <<http://esa.sdsc.edu/daily.htm>>.
8. Jocelyn Kaiser, "Role Model for Ecology's Generation X," *Science*, 18 February 2000, 287(5456):1191.
9. Simon Levin, *Fragile Dominion* (Reading, MA: Perseus Books, 1999), p. 204.
10. Graciela Chichilnisky and Geoffrey Heal, "Economic Returns from the Biosphere," *Nature* 391(February, 1998): 629-630.
11. Levin, *Fragile Dominion*, p. 204.
12. Edward O. Wilson, "What Is Nature Worth," *Wilson*

## On the value of natural ecosystems

*Quarterly*, Winter 2002, 26(1):20–39 at 23–24.

13. National Science Board, Task Force on the Environment, *Environmental Science and Engineering for the 21st Century: The Role of the National Science Foundation* <<http://www.nsf.gov/cgi-bin/getpub?nsb0022>> and <<http://www.nsf.gov/nsb/tfe/nsb99133/box1.htm>>.
14. Robert B. Jackson, Stephen R. Carpenter, Clifford N. Dahm, Diane M. McKnight, *et al.*, “Water in a Changing World,” published on line by the Ecological Society of America, *Issues in Ecology*, <<http://www.esa.org/issues9.htm>> and reprinted in *Ecological Applications* 11 (August, 2001): 1027–1045.
15. Chichilnisky and Heal, “*Economic Returns from the Biosphere*,” *Nature* 391 (February, 1998): 629–630.
16. Committee to Review the New York City Watershed Management Strategy, National Research Council [NRC], *Watershed Management for Potable Water Supply: Assessing the New York City Strategy* (Washington, DC: National Academy Press), p. 200, <[http://www.nap.edu/catalog/9677.html?se\\_side](http://www.nap.edu/catalog/9677.html?se_side)>.
17. NRC, p. 65.
18. NRC, p. 194.
19. NRC, p. 23.
20. NRC, pp. 77, 181.
21. NRC, p. 82.
22. NRC, p. 161.
23. NRC, p. 197.
24. NRC, p. 160.
25. *New York City Municipal Water Finance Authority* <<http://www.nyc.gov/html/nyw/home.html>>.
26. Raymond Orlando, Head of Investor Relations, New York City Municipal Water Finance Authority, telephone conversation with the author, 5 February 2002.
27. New York City Independent Budget Office, “The Clean Water/Clean Air Bond Act of 1996: Fiscal Impact on New York City” <<http://www.ibo.nyc.ny.us/iboreports/pubwater.html>>.
28. *Enhanced Surface Water Treatment Requirements*, 59 Fed. Reg. 38,832 (proposed July 29, 1994) (codified at 40 C.F.R. 141, 142).
29. W. R. MacKenzie, N. J. Hoxie, M. E. Proctor, M. S. Gradus, *et al.*, “A massive outbreak in Milwaukee of *Cryptosporidium* infection transmitted through the public water supply.” *New England Journal of Medicine*, 21 July 1994, 331(3):161–7.
30. American Water Works Association, *E-Mainstream* <<http://www.awwa.org/mainstream/archives/2001/september/ms0901ww.htm>>.
31. New York City Department of Environmental Protection, “New York City’s Water Supply System, Watershed Agreement Overview,” <<http://www.ci.nyc.ny.us/html/dep/html/agreement.html>>.
32. NRC, p. 107, citing NRC 1999 <<http://www.epa.gov/OWOW/watershed/framework.html>>.
33. NRC, p. 503.
34. NRC, p. 502.
35. World Resources Institute Report 2000–2001, p. 210 <[http://www.wri.org/wr2000/pdf/freshwater\\_nyc.pdf](http://www.wri.org/wr2000/pdf/freshwater_nyc.pdf)>.
36. Richard Perez-Pena, “Court Blocks A Water Plant In Bronx Park,” *New York Times*, 9 February 2001, p. B1.
37. Eric A Goldstein and Mark Izeman, “Plug the City’s Leaky Water Supply,” *Newsday*, 24 April 2001, p. A36.
38. Winnie Hu, “Group Says City Fails to Keep Its Part of a Clean-Water Pact,” *New York Times*, 28 June 2000, p. B4.
39. *New York Department of Natural Resources News Release* <<http://www.ci.nyc.ny.us/html/dep/html/press/01-50pr.html>>.
40. New York State Press Release, January 21, 1997, “Governor Pataki Signs Historic Agreement on NYC Watershed,” <<http://www.dec.state.ny.us/website/press/govrel/jan21.html>>.
41. Jackson, Carpenter, Dahm, McKnight, *et al.*, “Water in a Changing World,” <<http://www.esa.org/issues9.htm>>, reprinted in *Ecological Applications*.
42. John Stuart Mill, “Nature” in *Three Essays on Religion*, the 1874 edition (New York: Greenwood Press, 1969) <[http://www.lancs.ac.uk/users/philosophy/texts/mill\\_on.htm](http://www.lancs.ac.uk/users/philosophy/texts/mill_on.htm)>.
43. IP-203, *RAND Issue Papers* <<http://www.rand.org/scitech/stpi/ourfuture/NaturesServices/section1.html>>.